UL 746D

STANDARD FOR SAFETY

Polymeric Materials – Fabricated Parts

UL Standard for Safety for Polymeric Materials – Fabricated Parts, UL 746D

Eighth Edition, Dated January 26, 2018

SUMMARY OF TOPICS

This revision of ANSI/UL 746D dated July 20, 2023 includes a correction of Figure 10.1.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated May 12, 2023.

No Text on This Page

JANUARY 26, 2018
(Title Page Reprinted: July 20, 2023)

ANSI/UL 746D-2023

UL 746D

Standard for Polymeric Materials – Fabricated Parts

The first edition was titled Molded Plastic Parts for Use in Devices and Equipment and numbered UL 746.4.

First Edition – August, 1974
Second Edition – March, 1978
Third Edition – March, 1980
Fourth Edition – May, 1983
Fifth Edition – May, 1993
Sixth Edition – May, 1998
Seventh Edition – December, 2012

Eighth Edition

January 26, 2018

This ANSI/UL Standard for Safety consists of the Eighth Edition including revisions through July 20, 2023.

The most recent designation of ANSI/UL 746D as an American National Standard (ANSI) occurred on July 20, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 746D on November 3, 1998. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in ULSE's Collaborative Standards Development System (CSDS) at https://csds.ul.com.

No Text on This Page

CONTENTS

INTRODUCTION

MATERIAL MODIFICATIONS

MARKING

No Text on This Page

INTRODUCTION

1 Scope

1.1 These requirements cover a program applicable to parts that have been molded or fabricated from polymeric material and describe the material-identity control system intended to provide traceability of the material used for the polymeric parts through the handling, molding or fabrication, and shipping operations. Guidelines are also provided for acceptable blending or simple compounding operations that may affect risk of fire, electrical shock, or injury to persons.

1.2 This program is intended to provide quick verification of material identification by means of an identification marking on the part, or on the carton in which the part is shipped, or in a specification sheet placed within the shipping carton with the part. This program is intended to eliminate the uncertainty of the polymeric material identity in the end-use product and to reduce the possibility of field problems caused by the use of incorrect compounds.

1.3 The polymeric-material identity program covered by this standard is intended to provide traceability for molded finished parts (that is, enclosures, internal equipment parts, and the like) that are to be factory-installed components of other equipment where the acceptability of the combination is to be determined.

1.4 This program is not intended for manufacturing operations that add colorants or other additives to plastic materials using hot-compounding techniques that subject the material to an additional heat history and ship pellets as finished parts. This program is not intended to provide traceability for polymeric materials that are intended for field installation.

1.5 Requirements and methods for the evaluation of metallized or painted parts are contained in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and the requirements for Polymeric Materials – Short Term Property Evaluations, UL 746A. Reference should be made to the applicable individual product standard for performance requirements covering the part or assembly.

2 Glossary

2.1 For the purposes of this Standard the following definitions apply.

2.2 CO-MOLDING – The process of injecting or extruding two or more materials into a single mold using two or more plasticizing cylinders or through a single dye being fed by separate extruders either simultaneously or in sequence.

2.3 FABRICATOR – Performs such finishing operations as machining, drilling, painting, plating, assembly, hot stamping, and the like.

2.4 GENERICALLY – SIMILAR MATERIALS – Materials having the same basic chemical constituents and structure but differing in the amounts of fillers, modifiers, and/or reinforcements.

2.5 LET-DOWN RATIO – The proportion by weight of additive or concentrate to the base resin material. The maximum let-down ratio is the highest permissible proportion by weight of the additive or concentrate to the base resin material. The minimum let-down ratio is the lowest permissible proportion by weight of the additive or concentrate to the base resin material.

2.5A MECHANICALLY RECYCLED PLASTIC BASE COLOR – The color of the mechanically recycled resin arising from pigments and dyes that are in the as received resin and prior to any further addition of pigments or dyes. For example, the base color of a mechanically recycled plastics resin can be gray or

black with the actual color depending on the distribution of pigments and dyes given the multiple plastics being recycled in the recycled plastics stream.

2.5B MECHANICALLY RECYCLED PLASTICS – Those plastics composed of post-consumer material or post-industrial material only, or both, that may or may not have been subjected to additional processing steps of the types used to make products such as mechanically recycled-regrind, or reprocessed plastic.

2.6 MOLDER – Performs injection, extrusion, transfer, compression, rotational, co-molding, thermoforming, reaction injection molding, pultrusion, open mold or hand lay-up processes.

2.7 POLYMERIC MATERIAL – A compound formed by chemical reaction that results in large molecules whose molecular weight is a multiple of that of the original substance (monomer). Includes thermoplastic, thermoset, and elastomeric materials.

2.8 RECONSTITUTED PLASTIC – A material made by chemical or thermal breakdown of plastic waste into components followed by their conversion into a final composition by chemical action.

2.9 *Deleted*

2.10 *Deleted*

2.11 RECYCLED PLASTICS STREAM– Plastic pellets incorporating one or more grades of the plastic material that has been mechanically recovered from post-consumer or post-industrial sources.

2.12 REGRIND – A noncontaminated product or scrap such as sprues and runners that have been reclaimed by shredding and granulating for use in-house.

2.12A RELATED VIRGIN RESIN – Existing virgin material from which the recycle material composition is derived.

2.13 REPROCESSED PLASTIC – Regrind or mechanically recycled-regrind material that has been processed for reuse by extruding and forming into pellets or by other appropriate treatment.

3 References

3.1 General

3.1.1 Any undated reference to a code or standard appearing in the requirements of this Standard shall be interpreted as referring to the latest edition of that code or standard.

3.2 Related Standards

3.2.1 The requirements in Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, covers flammability of polymeric materials used for parts in devices and appliances. The Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, contains short-term test procedures to be used for the evaluation of materials used for parts intended for specific applications in electrical end products. The Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, contains long-term test procedures to be used for the evaluation of materials used for parts intended for specific applications in end products. Test procedures are provided in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, for the evaluation of polymeric materials in specific applications in end products. The test procedures include reference to the data obtained from the standard property tests in UL 746A, as well as other practical means of evaluation.

3.2.2 Requirements for materials that have been modified to match the requirements of a specific application, including the use of recycled and regrind materials, the use of additives and colorants, and the blending of two or more materials, are described in this Standard.

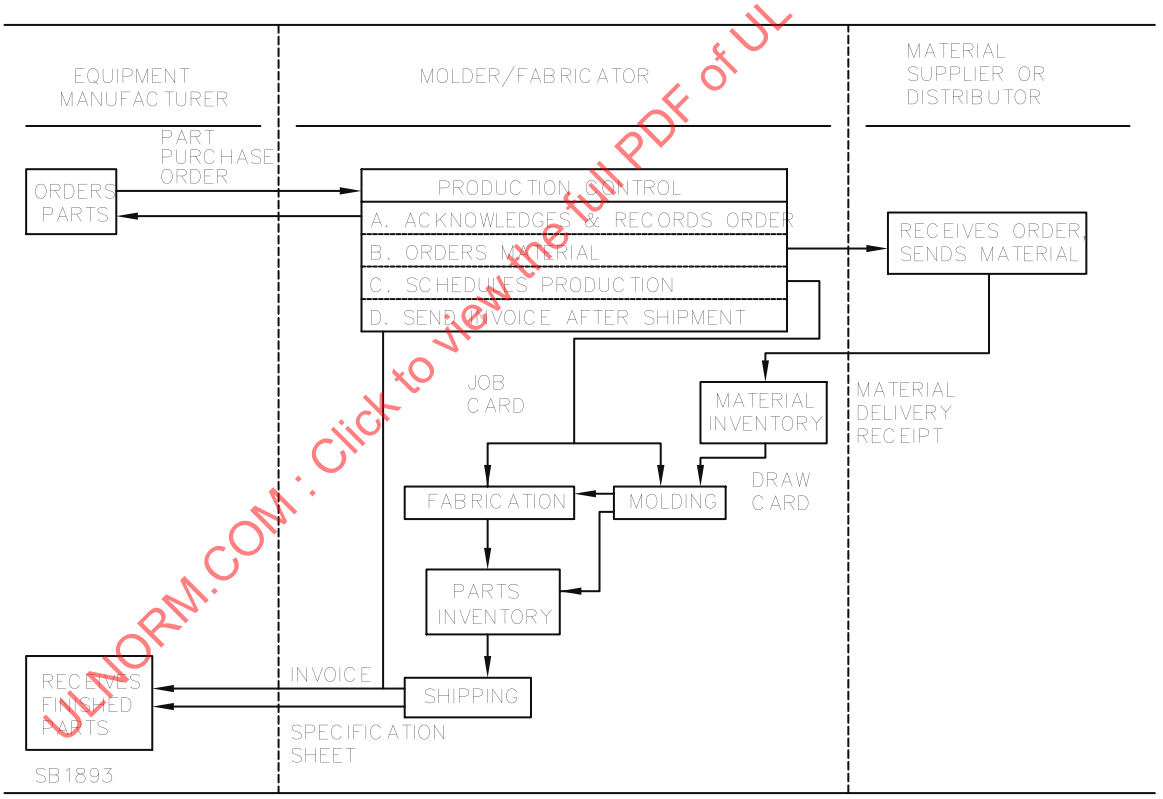
4 Details

4.1 The molder/fabricator of the polymeric-material parts shall maintain records that facilitate tracing the identity of the polymeric material used in the molding/fabrication of the parts from its receipt from the material supplier, through storage, handling, molding, finishing operations, and shipping. See Figure 4.1.

Exception: Records covering subcontracted fabrication processes are not required if the markings described in Details, Section 11 are permanently molded into, or applied to the part, and the integrity of the marking is intact after all fabrication processes.

Figure 4.1

Example of a material-identity control system as described in section 4



4.2 The following is an example of the records that may be maintained by the molder/fabricator to comply with the requirements in 4.1.

a) Purchase Order – Orders part or assembly from a molder/fabricator. This form generally is to include the following entries:

1) Name of end-product manufacturer or designated party (consignee).

2) Purchase order number.

3) Part (assembly or drawing) number and/or name. This item is to specify the material to be used for production of the component.

4) Quantity ordered.

5) Date.

b) Internal Record of Purchase Order – Transfers information from purchase order to molder's/fabricator's in-house records. This form is to include the following entries:

1) Name of end-product manufacturer or designated party.

2) Purchase order number.

3) Internal work order number. See 4.3

4) Part (assembly or drawing) number and/or name.

5) Quantity ordered.

6) Date.

c) Material Delivery Receipt – Records receipt of material from which finished parts are molded/fabricated. The following entries are to correlate with like entries on the Material Inventory:

1) Material manufacturer's name or trade name.

2) Material designation.

3) Quantity delivered.

4) Date delivered.

d) Material Inventory (See 4.6) – Records quantity of material in storage as well as receipts and withdrawals. The following entries are to correlate with like entries on the Material Delivery Receipt and Material Draw:

1) Material manufacturer's name or trade name.

2) Material designation.

3) Quantity delivered.

4) Date delivered.

5) Quantity withdrawn.

6) Date withdrawn.

e) Material Draw – Records withdrawal of material from inventory for part molding/fabrication. The following entries are to correlate with like entries on the Material Inventory. The date of withdrawal is to approximate the molding/fabrication date on the Parts Identification.

1) Material manufacturer's name or trade name.

2) Material designation.

3) Quantity withdrawn.

4) Date withdrawn.

f) Job Card – Records details regarding molding/fabrication of finished parts. The following entries are to correlate with like entries on the Purchase Order, Internal Record of Purchase Order, and Parts Inventory. The date of molding/fabrication is to approximate the molding/fabrication date on the Parts Identification.

1) Part (assembly or drawing) number and/or name.

2) Internal work order number. See 4.3.

3) Material manufacturer's name or trade name.

4) Material designation. See 5.2 for material modifications and 8.4 for parts containing regrind.

5) Quantity of parts produced.

6) Date produced.

g) PARTS INVENTORY – Records quantity of finished parts in storage as well as additions and shipments. The following entries are to correlate with like entries on the Job Card (additions) and Invoice (shipments). The added date is to approximate the molding/fabrication date on the Parts Identification:

1) Part (assembly or drawing) number and/or name.

2) Internal work order number. See 4.3.

3) Quantity added.

4) Date added.

5) Quantity withdrawn.

6) Date withdrawn.

h) Invoice – Records shipment of finished parts. The following entries are to correlate with like entries on the Purchase Order, Internal Record of Purchase Order, Job Card, and Parts Inventory:

1) Name of end-product manufacturer or designated party.

2) Part (assembly or drawing) name and/or number.

3) Quantity shipped.

4) Date shipped.

i) Parts Identification – See 4.4 and Marking, Section 11.

1) Molder's/fabricator's name.

2) Assigned designation. See 4.5.

3) Part (assembly or drawing) number and/or name.

4) Molding/fabrication date.

5) Material manufacturer's name or trade name.

6) Material designation.

4.3 The molder/fabricator may elect to represent the name of the end-product manufacturer or designated party; purchase order number; assembly, part or drawing number; and/or part name, by an internal code or work-order number on the molder/fabricator in-house records.

4.4 When an assembly consists of two or more polymeric parts, complete material identification is to be provided for each component part.

4.5 If subassemblies of the complete device are manufactured at locations where traceability cannot be evaluated, the assigned designation shall not be used (see 11.1).

4.6 A material may be used for products not covered by the material-identity traceability system as well. The quantities necessary for these products may be ordered or withdrawn on the same records as the material necessary for the products that do fall under the traceability system.

4.7 The records indicated in 4.1 are to be maintained on a ready-access basis for at least 3 months and in storage for at least 2 years.

MATERIAL MODIFICATIONS

5 Additives

5.1 The molder/fabricator shall not employ colorants, flame retardants, fillers, mold-release lubricants, color concentrates, dyestuff, chemical blowing agents or reinforcements or any combination in conjunction with the polymeric material unless the additive or concentrate is tested and found not to adversely affect the critical properties of the material. If an additive or concentrate of unknown performance is employed, the assigned designation mentioned in 11.1 shall not be used.

Exception No. 1: Mold-release lubricants that are applied directly to the mold die may be employed without additional tests for materials that have been classed HB in accordance with the requirements in Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. A mold-release lubricant may be used with a material classed V-2 or better provided that the results of testing indicate that UL 94 flammability classification remains unchanged when the lubricant is applied to either molded bar specimens or molded parts of material from the same generic material type.

Exception No. 2: Chemical blowing agents may be employed to eliminate sink marks on finished parts if the specific gravity of the finished part is not less than 95 percent of the specific gravity of the unfoamed material. This exception does not apply to rigid foamed materials that generally result in a much lower density than the unfoamed material.

Exception No. 3: Dyestuff that is suspended in water may be used by a molder/fabricator to apply color to the outer surface of a molded part made from materials classed HB or from unpigmented nylon that has been classed HB or V-2 in accordance with the requirements in Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception No. 4: Color concentrates, colorants and dyestuff that have been classed HB or better when used in a generic material category, may be dry-blended without additional tests with polymeric materials that have been classed HB from the same generic material category. The molder/fabricator may dry-blend a color concentrate, colorant or dyestuff with a material classed V-2 or better provided that the UL 94 flammability classification remains unchanged when the color concentrate, colorant or dyestuff is let-down into the specific grade of base resin material. The molder/fabricator may dry-blend color concentrate, colorant or dyestuff in a let-down ratio that is equal to or less than the maximum let-down ratio maintained and reported for the pigmented molded bar specimens or parts that are subjected to the UL 94 flammability test.

Exception No. 5: The molder/fabricator may dry-blend a flame retardant concentrate into a specific grade of a base resin material in a let-down ratio that is equal to or greater than the minimum let-down ratio maintained and reported for the samples that were subjected to the UL 94 flammability test to obtain the indicated flammability classification.

5.2 If acceptable additives are employed, the job card described in 4.2(f) shall describe the nature and quantity of the additive or concentrate.

6 Rework

6.1 The molder/fabricator shall not employ any compounds or other materials to repair voids, cracks, deficiencies or other defects in molded parts, unless the repair compound or material and the repair process have been evaluated and found not to adversely affect the critical properties of the material or molded parts.

7 Combined Resins

7.1 Materials can be formulated to match the requirements of a specific application. Tumble blending of two materials of the same approximate particle size is a method that a molder/fabricator may employ to customize the compound for the specific application. The requirements of this section cover particulate blending of molding powders and pellets by dry, cold compounding techniques. Figure 7.1 illustrates the requirements described in 7.4 – 7.6.

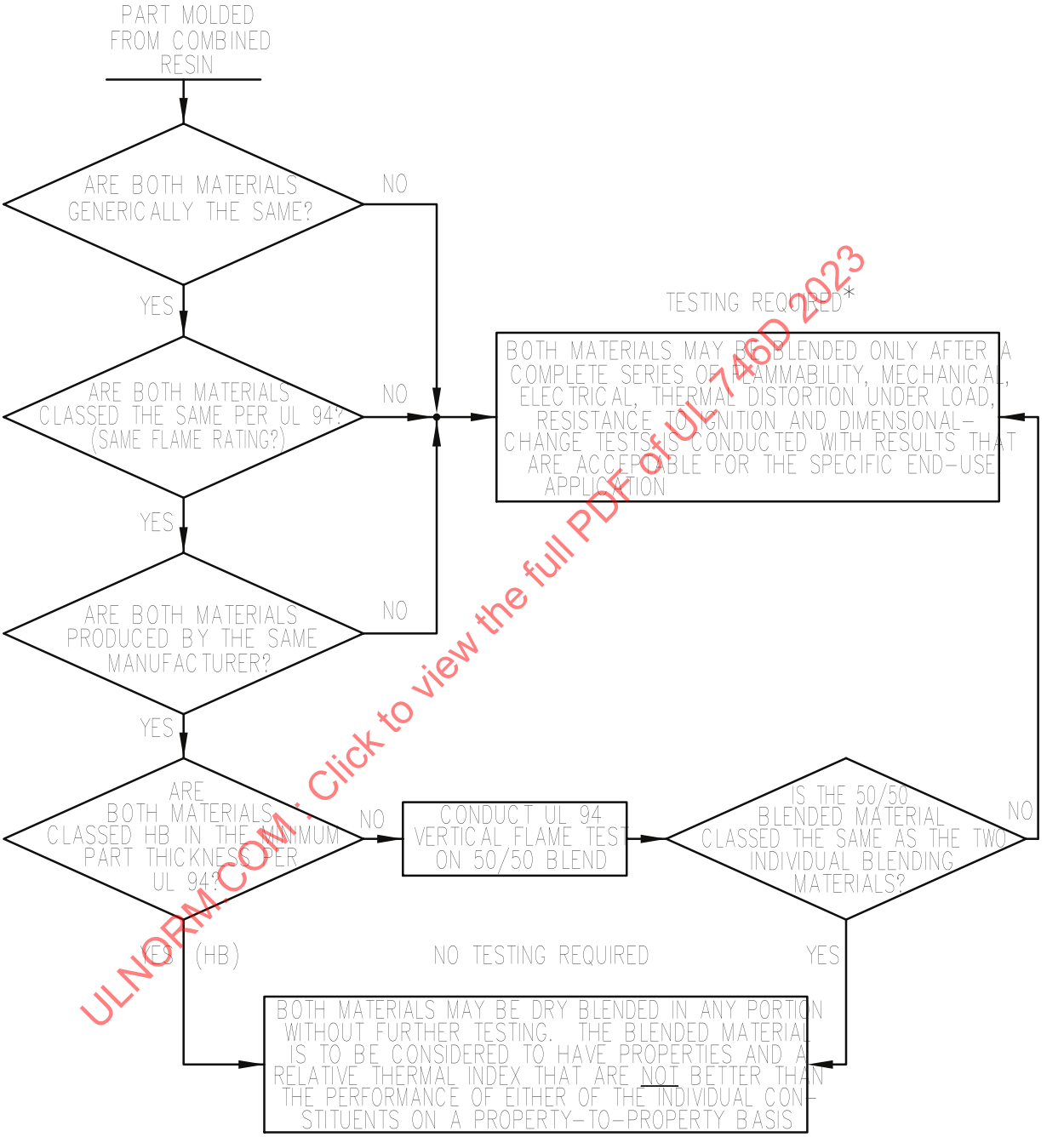
7.2 These requirements do not apply to co-molding materials. Co-Molding, Section 9, describes requirements for co-molding operations.

7.3 This Section provides guidelines on the development of criteria that may be used to evaluate combined materials if small-scale-test data is available using the methods described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A. The finished part shall possess minimum property levels and a relative thermal index that is considered acceptable for the application as described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C; Polymeric Materials – Long Term Property Evaluations, UL 746B; or as described in the specific product standard.

7.4 Two generically similar materials produced by the same manufacturer that are classed HB in the minimum part thickness when tested in accordance with the requirements in Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, may be dry blended in any portion by the molder/fabricator without further testing. The blended material is to be considered to have properties and a relative thermal index that are not better than the performance of either of the individual constituents on a property-to-property basis.

Figure 7.1

Test considerations for combined resins



7.5 Two generically similar materials produced by the same manufacturer, each classed V-0, or V-1, or V-2 in the minimum part thickness when tested in accordance with the requirements in Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, may be dry blended in any proportion by the molder/fabricator provided that the results of testing the 50/50 percent by volume blend indicate that the UL 94 flammability classification remains unchanged. The blended material is to be considered to have properties and a relative thermal index that are not better than the performance of either of the individual constituents on a property-to-property basis.

7.6 Two materials that are generically different (this includes the blending of materials where one or both components are copolymers, alloys, terpolymers, and the like), or have different UL 94 flammability classifications, or have the same UL 94 flammability classification but are produced by different manufacturers, may be blended by a molder/fabricator only after a complete series of flammability, mechanical, electrical, thermal distortion under load, resistance to ignition, and dimensional-change tests are conducted with results that are acceptable for the specific end-use application.

Exception: Two generically similar materials or polystyrene and styrene/butadiene copolymer blends classed HB that may be produced by different manufacturers are to be evaluated in accordance with the requirements in 7.4.

7.7 The material identity required in 11.2(c) shall include each material manufacturer's name or trade name, material designation, and approximate percentage or ratio of each component material.

8 Regrinds

8.1 Thermoset regrind shall not be employed in the molding/fabrication of parts, unless the results of a separate investigation indicate acceptable performance for the specific part that contains regrind.

8.2 Parts shall not be molded from material that contains more than 25-percent thermoplastic regrind by weight, that has been dry blended by the molder with the same grade of virgin material, unless the results of a separate investigation indicate acceptable performance for the specific part.

8.3 Any increase in the amount or change of the type of regrind shall require a separate investigation to determine the effects of the modification.

8.4 The job card required in 4.2(f) shall include the maximum amount of regrind that the parts contain in situations where the regrind content exceeds the limits specified in 8.1 and 8.2.

8.5 The separate investigation mentioned in 8.2 and 8.3 shall include an analysis of the part function; establishment of minimum performance levels for characteristics involving risk of fire, electric shock, or injury to persons; determination of the need for thermal aging and the establishment of a manufacturer's production control plan to maintain a minimum performance level. Specimens of the part shall be made from repeated blending of virgin and reground materials of the specified percentages until the residue of the material used in the first molding cycle is less than 1 percent of the total material in the part being tested (or the 20th molding cycle whichever comes first).

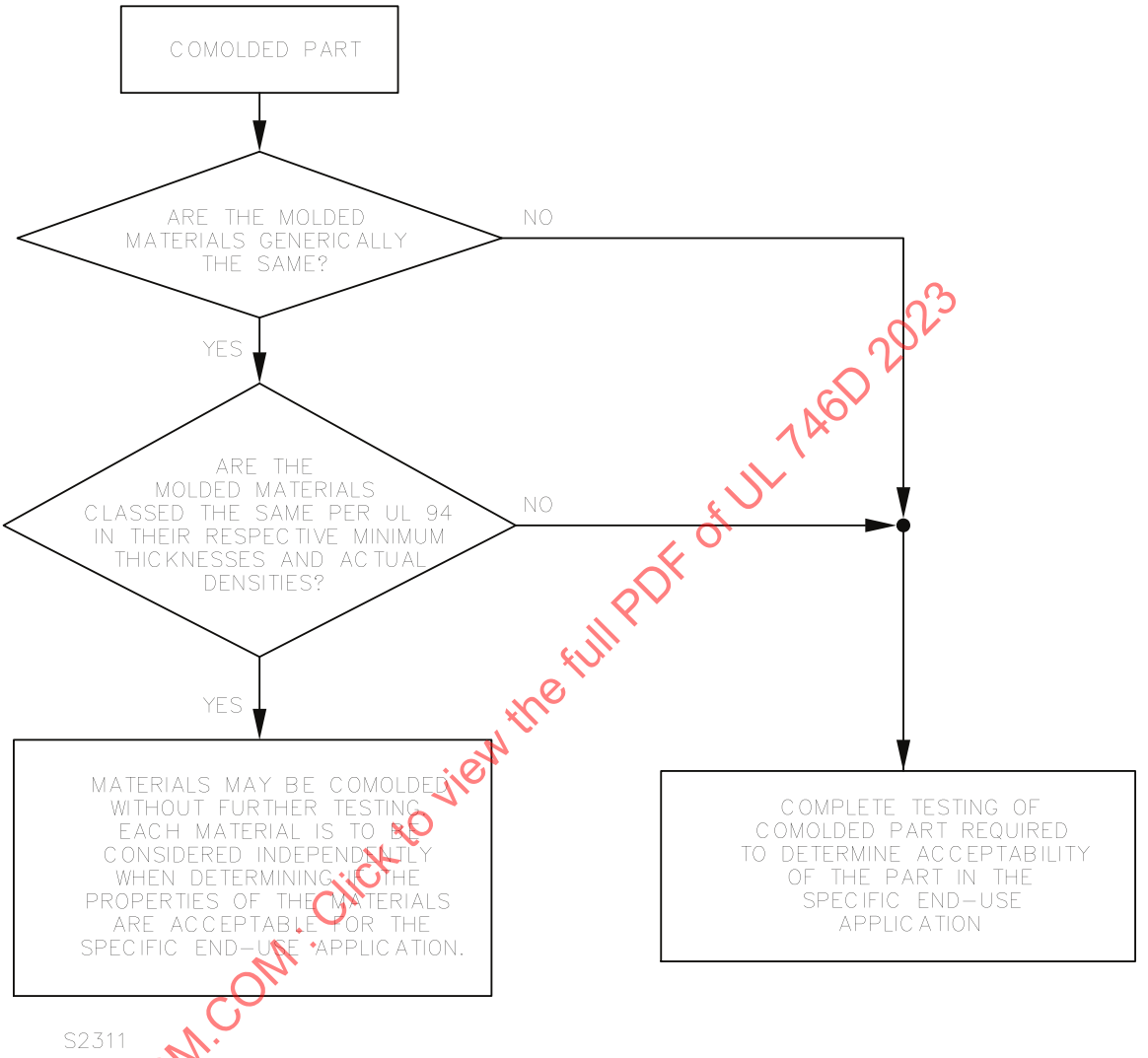
Exception: For processes that include only one blending of regrind material, from which no additional material is reclaimed for further regrind, then specimens of the part may be made from only one blending of virgin and reground materials of the specified percentages.

9 Co-Molding

9.1 Co-molded parts that are produced on a molding machine are to be evaluated with respect to the test considerations indicated in Figure 9.1

Figure 9.1

Test considerations for co-molding operations



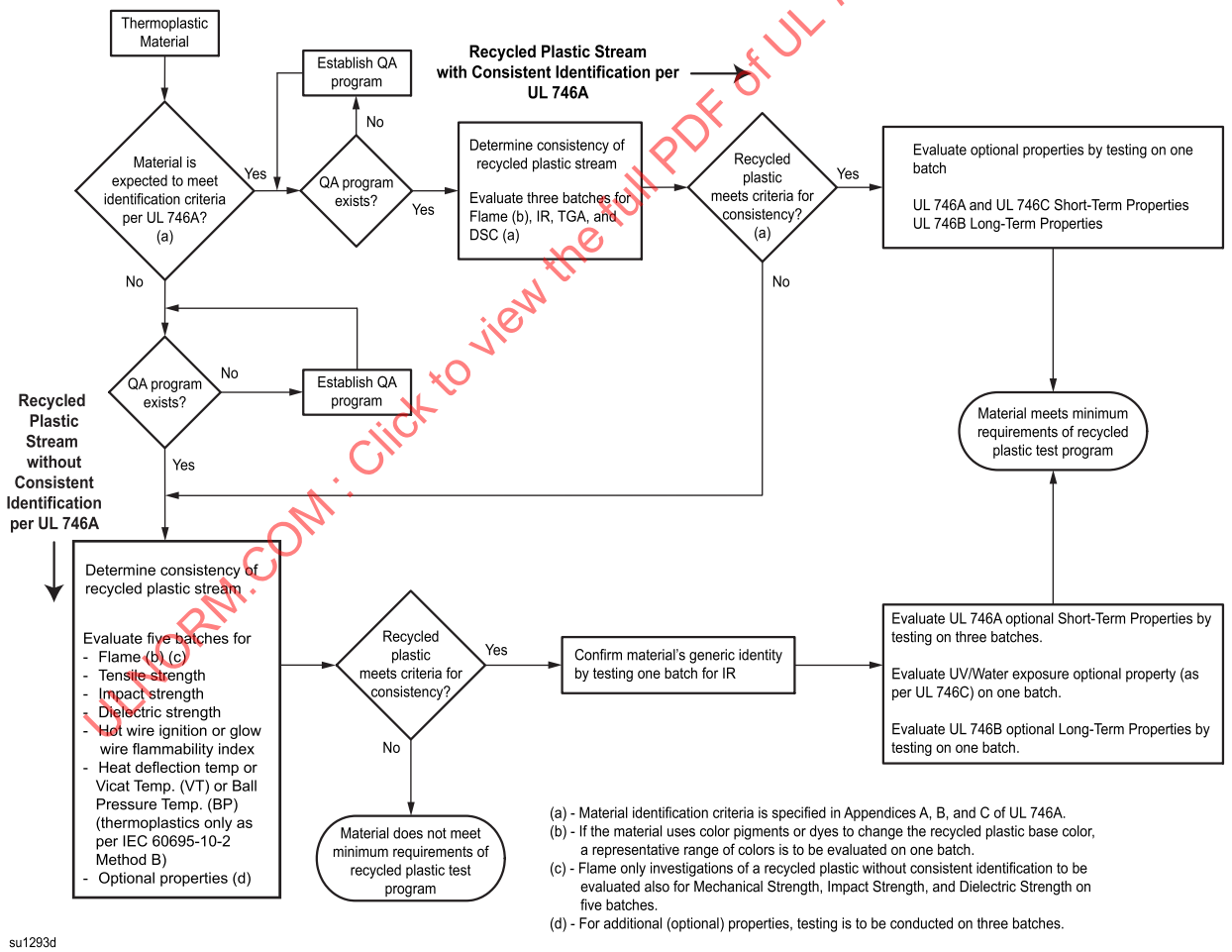
10 Mechanically Recycled Plastic

10.1 General

10.1.1 Mechanically recycled plastics as described in 2.5B shall be evaluated to determine whether the variations between production batches have significantly affected critical material properties. Figure 10.1 illustrates the test program for recycled thermoplastic materials and the following paragraphs describe the test requirements and acceptability criteria.

Figure 10.1

Mechanically recycled thermoplastic material test program



10.2 Mechanically Recycled Plastics with Consistent Identification

10.2.1 Mechanically recycled plastics as described in 2.5B meeting the identification comparison criteria in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, are to be categorized as recycled plastics with consistent identification.

10.2.2 Mechanically recycled plastics described in 2.5B that are expected to meet the identification criteria in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, between different batches are to have a complete series of UL 94 flammability and UL 746A identification tests, conducted on specimens for three production batches.

10.2.3 Results of tests for the three production batches are expected to meet the following requirements:

a) The identification tests per UL 746A are to be comparable between batches.

b) The same flammability rating is to be maintained for all tested production batches in the mechanically recycled plastic base color or if base color is not part of the evaluation, a commonly produced color that is part of the evaluation can be considered for complete series of UL 94 flammability and UL 746A identification tests, on three production batches.

c) For additional colors, only one production batch is required for flammability testing in compliance with 7.3.4, 8.3.4 or 9.3.4 in UL 94, as applicable, and the rating of this one batch shall be the same as the rating of the recycled plastic color that was evaluated for three production batches.

10.2.4 For evaluation of additional short and long term properties, testing of specimens from one production batch is to be conducted.

a) Short term properties include ignition (HWI, HAI, GWFI, GWIT), tracking (CTI, IPT, HVTR, D495), outdoor exposure (UV, Water), mechanical (Tensile, Impact), electrical (Dielectric), as referenced in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A,

b) Long term properties include Tensile Strength, Electrical Strength, or Impact Strength evaluated through heat aging per the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

10.2.5 A generic relative thermal index (RTI), per UL 746B, shall be assigned according to the generic identity of the recycled plastic ascertained through Infrared Analysis per UL 746A.

10.2.6 Table 10.0 indicates the criteria for assigning Relative Thermal Index (RTI) to an existing plastic material with elevated RTIs for cases pertaining to addition, deletion and change-in-level of recycled resin with consistent identification. If the identification test results of the recycled plastics do not compare favorably to a related virgin resin with an elevated RTI, the recycled plastic shall obtain an elevated RTI through a 4-point Long Term Thermal Aging program described in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B. In that case the recycle material evaluated shall be a new designation.

10.2.7 Table 10.0 indicate the criteria for assigning UV/water resistance rating to an existing plastic material having UV/water resistance rating for cases pertaining to addition, deletion and change-in-level of recycled resin with consistent identification. UV/Water resistance properties described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C are to be evaluated on one batch for each representative color. If the identification test results of the recycled plastic do not compare favorably to a related virgin resin with UV/Water resistance rating, the recycled material evaluated shall be a new designation.